DEVELOPMENT
OF AN
ECONOMIC DUST PALLIATIVE
FOR
LIMESTONE SURFACED SECONDARY ROADS

PROGRESS REPORT
NOVEMBER 1988

IOWA DOT PROJECT HR-297
ERI PROJECT 1925

Sponsored by the Highway Division of the
Iowa Department of Transportation and the
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ENGINEERING RESEARCH INSTITUTE

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ABSTRACT

Research activities during this period concentrated on continuation of field and laboratory testing for the Dallas County test road. Stationary ditch collection of dust was eliminated because of inconsistent data, and because of vandalism to collectors. Braking tests were developed and initiated to evaluate the influence of treatments on braking and safety characteristics of the test sections. Dust testing was initiated for out of the wheelpath conditions as well as in the wheelpath.

Contrary to the results obtained during the summer and fall of 1987, the 1.5 percent bentonite treatment appears to be outperforming the other bentonite treated sections after over a year of service. Overall dust reduction appears to average between 25 to 35 percent. Dallas County applied 300 tons per mile of class A roadstone maintenance surfacing to the test road in August 1988. Test data indicates that the bentonite is capable of interacting and functioning to reduce dust generation of the new surfacing material. Again, the 1.5 percent bentonite treatment appeared the most effective. The fine particulate bonding and aggregation mechanism of the bentonite appears recoverable from the environmental effects of winter, and from alternating wet and dry road surface conditions.

The magnesium chloride treatment appears capable of long-term (over one year) dust reduction and exhibited an overall average reduction in the range of 15 to 30 percent. The magnesium chloride treatment also appears capable of interacting with newly applied crushed stone to reduce dust generation.

Two additional one mile test roads were to have been constructed early this year. Due to an extremely dry spring and summer, construction scheduling was not possible until August. This would have allowed only minimal data collection. Considering this and the fact that this was an atypically dry summer, it was our opinion that it would be in the best interest of the research project to extend the project (at no additional cost) for a period of one year. The two additional test roads will be constructed in early spring 1989 in Adair and Marion counties.

INTRODUCTION

The following progress report covers the period from February through November, 1988. During this period testing continued on the test road constructed in Dallas County in 1987. Two additional one mile test roads were to have been constructed early this year. Due to the extremely dry spring and summer, the participating palliative contractor was very busy; therefore, construction was not possible until August which would have allowed only a minimal amount of data collection. Considering this and the fact that this was an atypically dry summer, it was our opinion that it would be in the best interest of all parties to extend the project (at no additional cost) for a period of one year. The two additional test roads will be constructed early spring 1989 in Adair and Marion counties.

DALLAS COUNTY TEST ROAD

The selection process and location of the Dallas County test road was detailed in the February 1988 progress report. The test road layout is shown on Figure 1. On August 15, 1988, class A crushed limestone maintenance surfacing material was applied by Dallas County to the test road at a rate of 300 tons per mile.

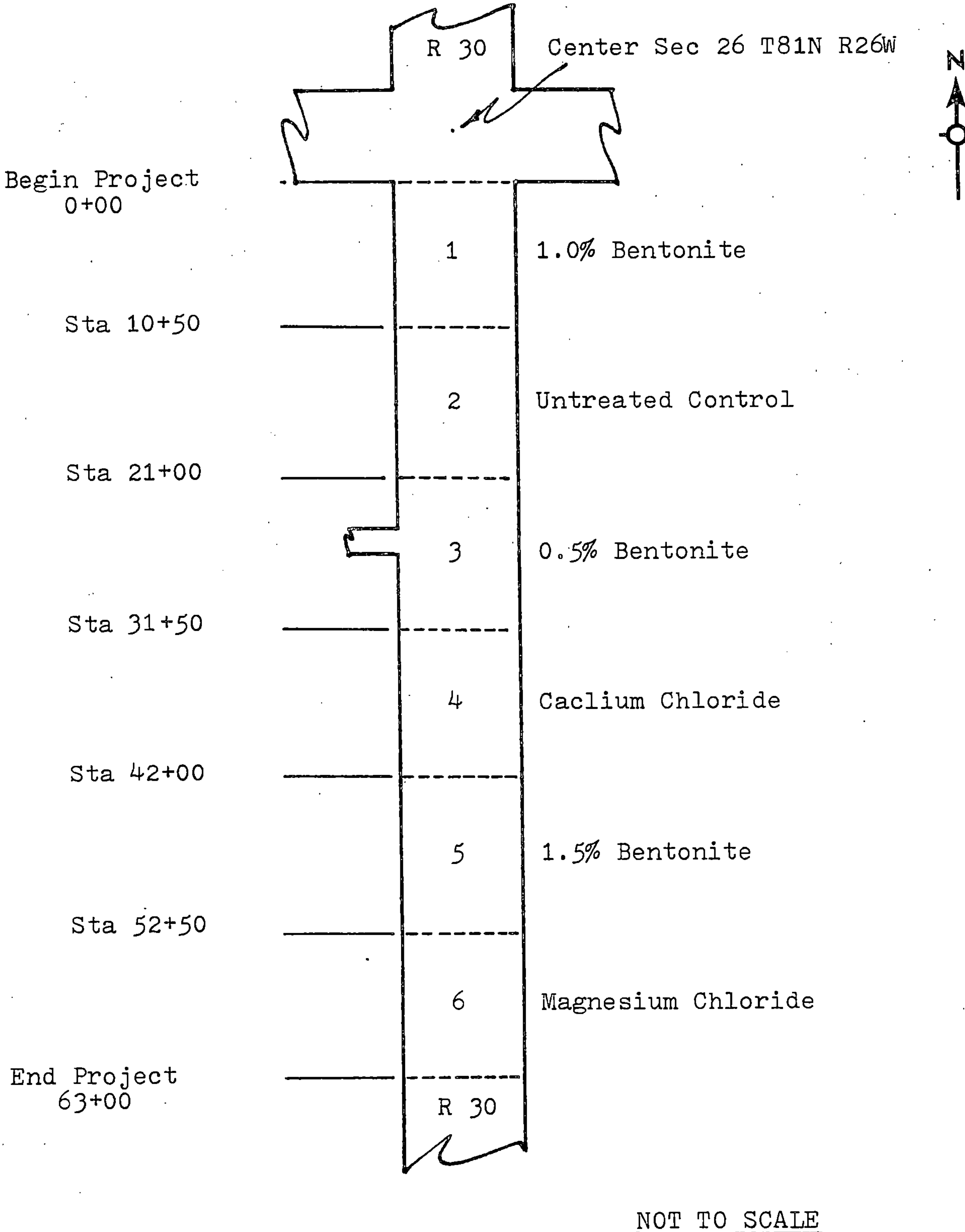


Figure 1. Dallas County test road layout, as constructed

FIELD TESTING

Field testing procedures are detailed in the February 1988 progress report. Field testing for this reporting period was modified as follows.

- Stationary ditch collection was eliminated because the previous data appeared inconsistent and vandalism was a problem.
- Additional testing using the high volume air samplers included dust generations out of the wheelpath, along with in the wheelpath testing.
- Braking tests were initiated to evaluate the influence of treatment on braking and safety characteristics.

The following sections of this report discuss the results of testing conducted for this period. Comparisons are made with previous data where appropriate. Of primary interest was the influence of time and environment on the fine particulate bonding capability of the bentonite treated sections. Normal maintenance procedures have been followed by the County and no additional palliative treatments have been applied since construction.

Rainfall Data

Rainfall data was collected from the Ames, Boone, and Perry weather stations. Rainfall on the test road was estimated by using mathematical weighting techniques and is summarized on

Figure 2. Data shown are in days from the time of construction in October 1987.

Dust Generation

Two high volume stationary air samplers manufactured by General Metal Works were used to collect dust samples. Dust testing was conducted periodically as weather permitted. Both air samplers were placed in the center of each test section, one on each side of the road. The sampler blower motors were powered by a gas generator. Ten passes of a vehicle traveling at a speed between 40 to 45 mph were made between the samplers for each test. Testing was conducted both in and out of the wheelpaths. Since the wheelpaths tend to develop a crust, out of the wheelpath tests were initiated to evaluate treatment effectiveness for the loose surficial material. The filters containing the collected dust were sealed in the field and returned to the laboratory for testing. The amount of dust collected from each section was compared to the untreated section. Results are shown graphically on Figures 3 through 7 for in the wheelpath and out of the wheelpath tests.

Comparison of the data for the bentonite treated sections in the wheelpath (shown on Figures 3, 4, and 5) indicates little consistent effect on dust generation up to when the new stone was applied in August. Dust was significantly (20 to 50

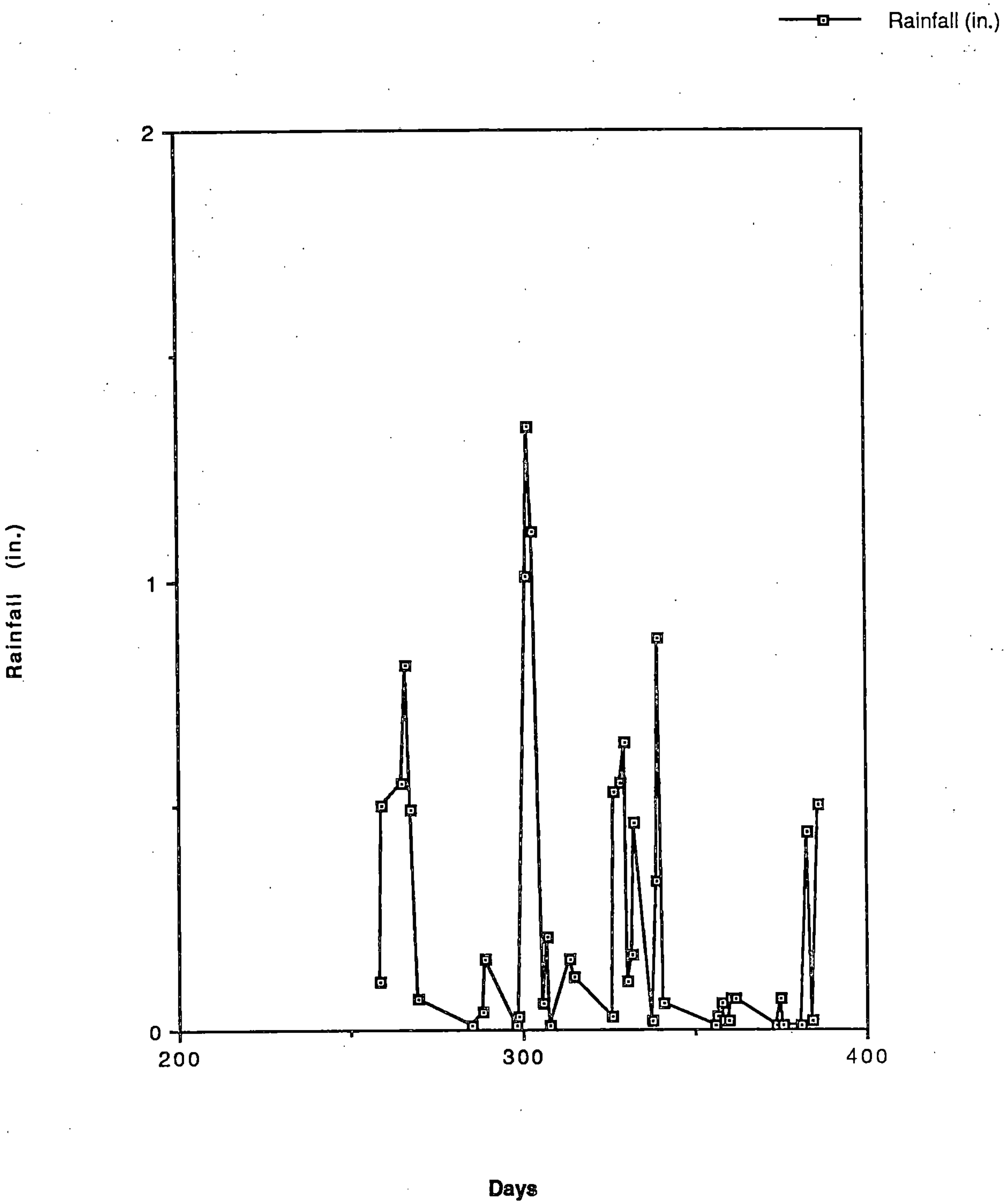
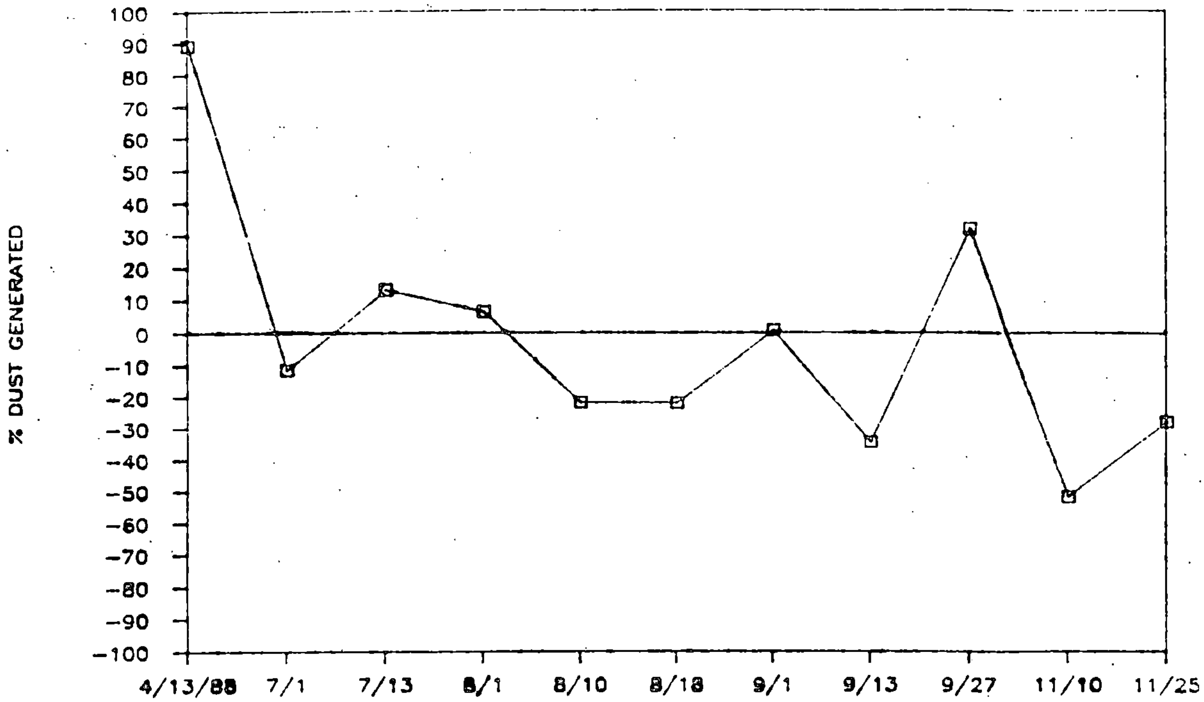


Figure 2. Weighted rainfall data, Dallas County test road

DUST FROM THE WHEEL PATHS



DUST FROM OUT OF THE WHEEL PATHS

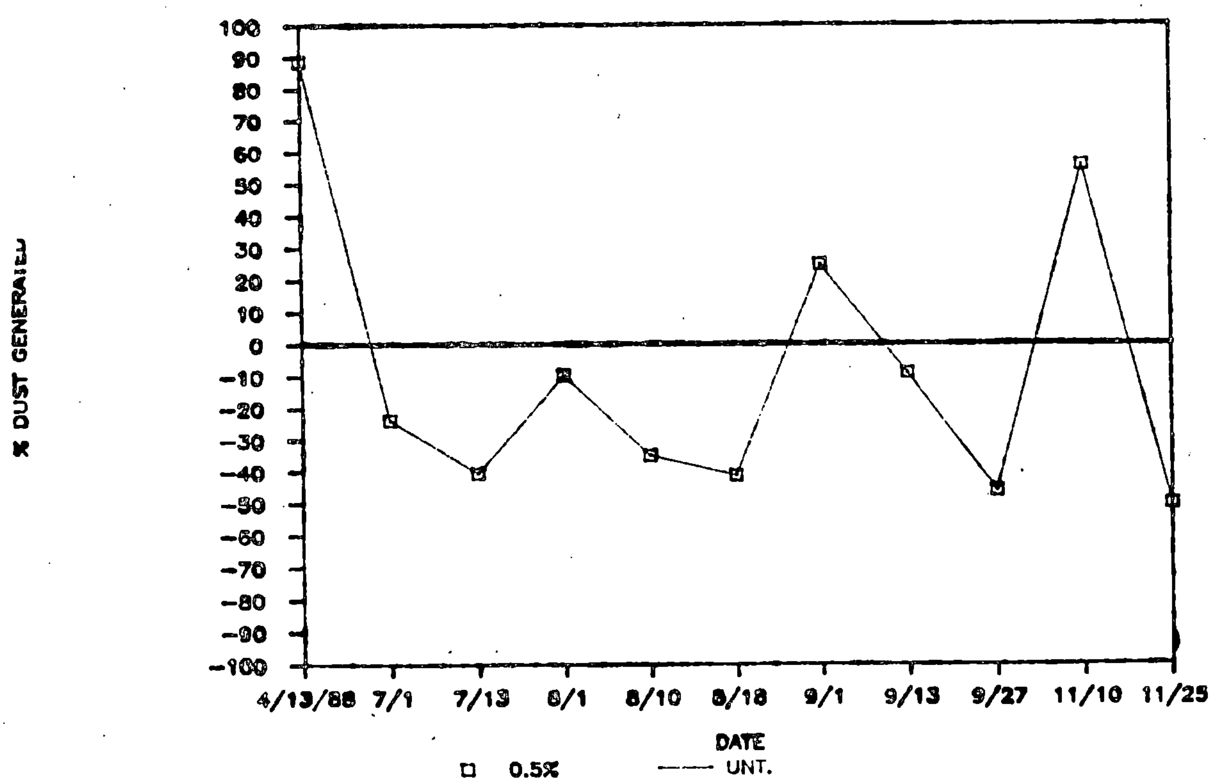


Figure 3. Dust generation, 0.5 percent bentonite treatment

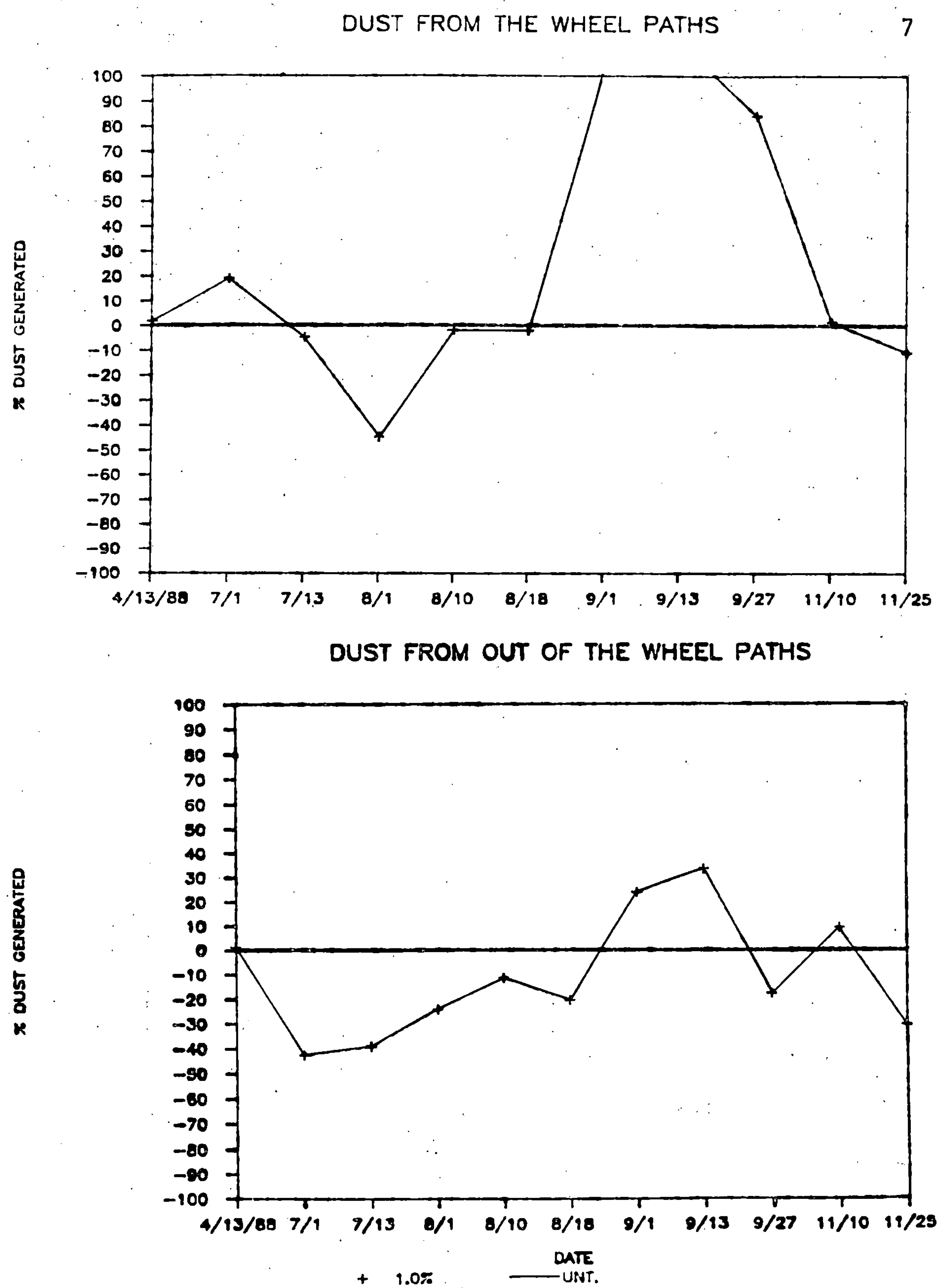


Figure 4. Dust generation, 1.0 percent bentonite treatment

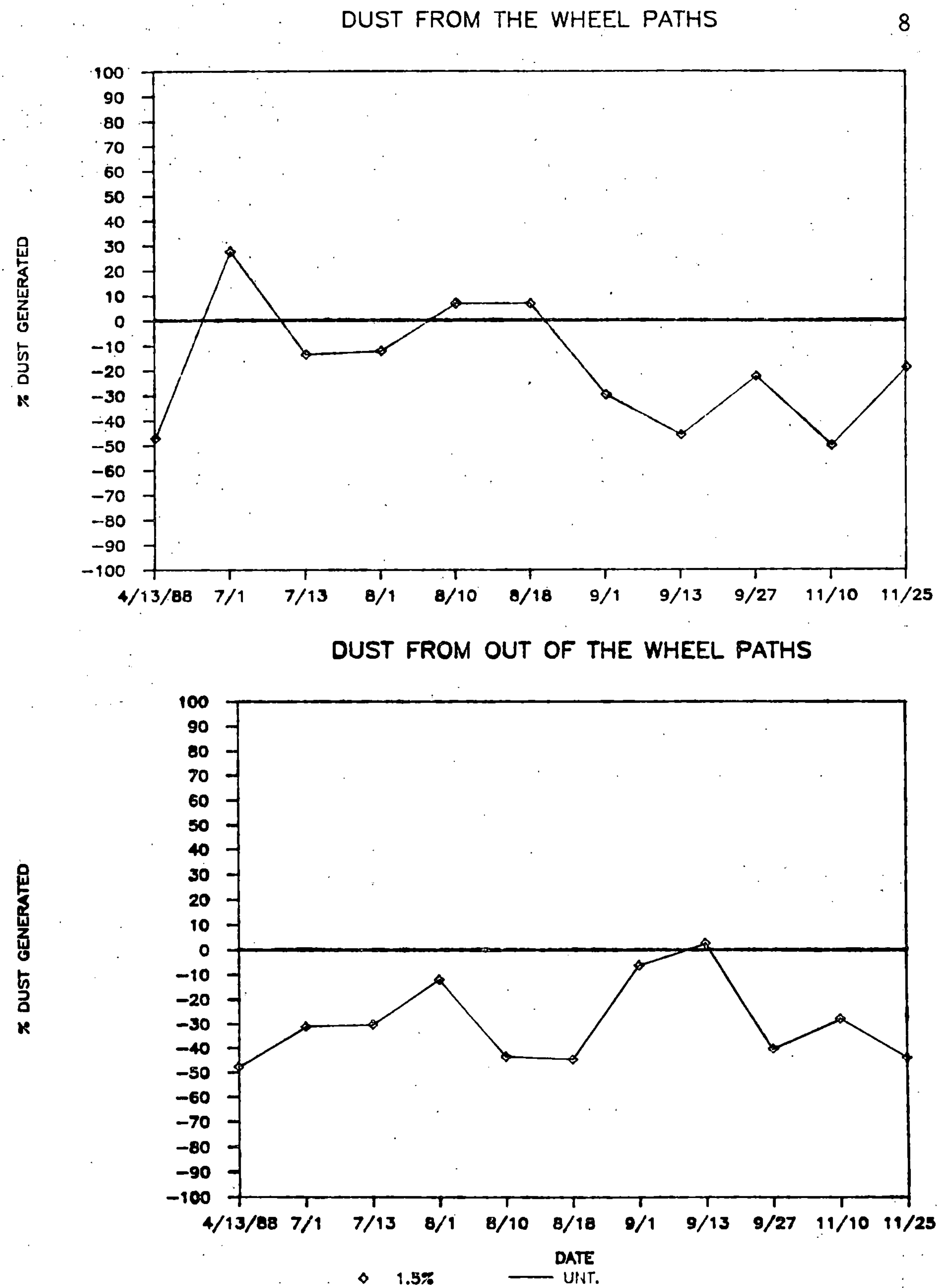
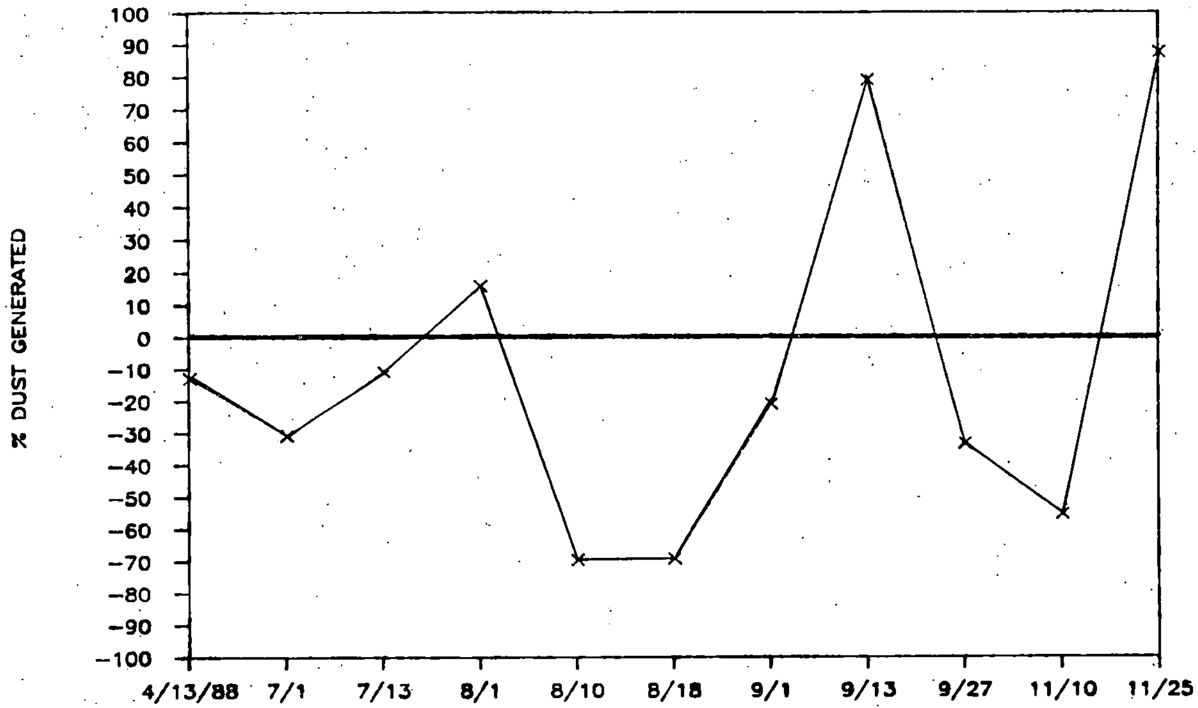


Figure 5. Dust generation, 1.5 percent bentonite treatment

DUST FROM THE WHEEL PATHS



DUST FROM OUT OF THE WHEEL PATHS

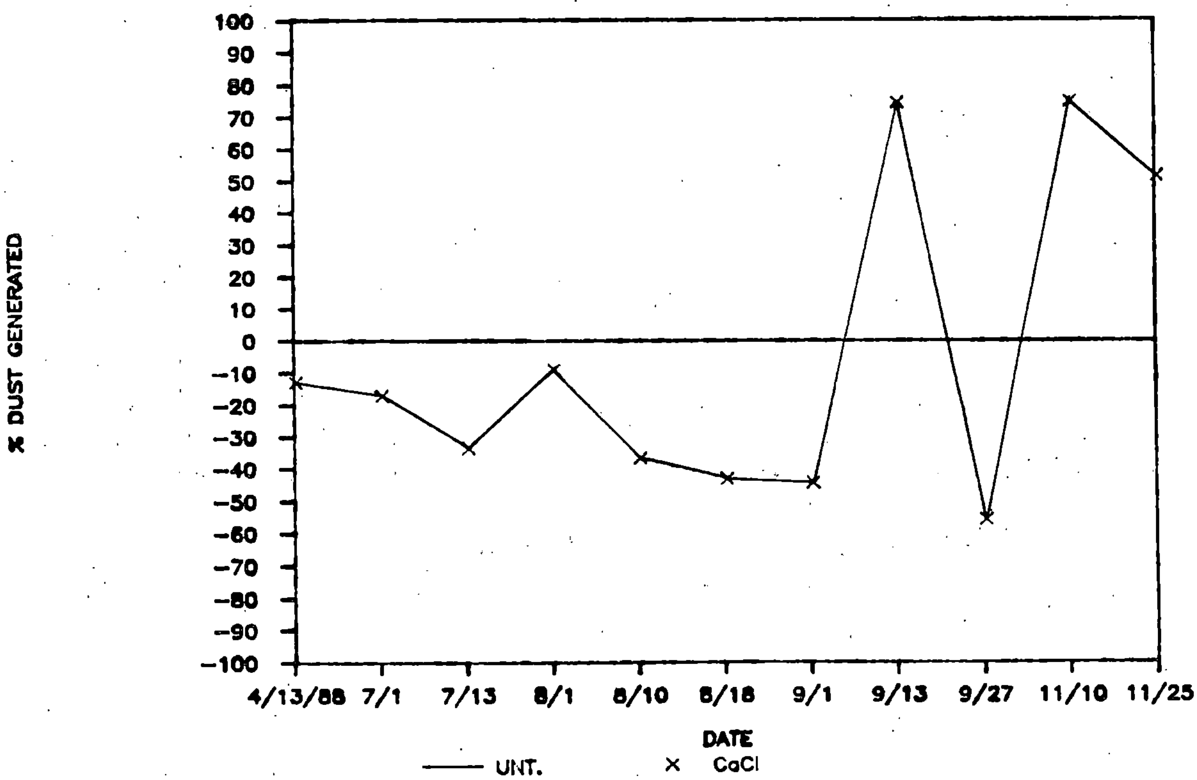
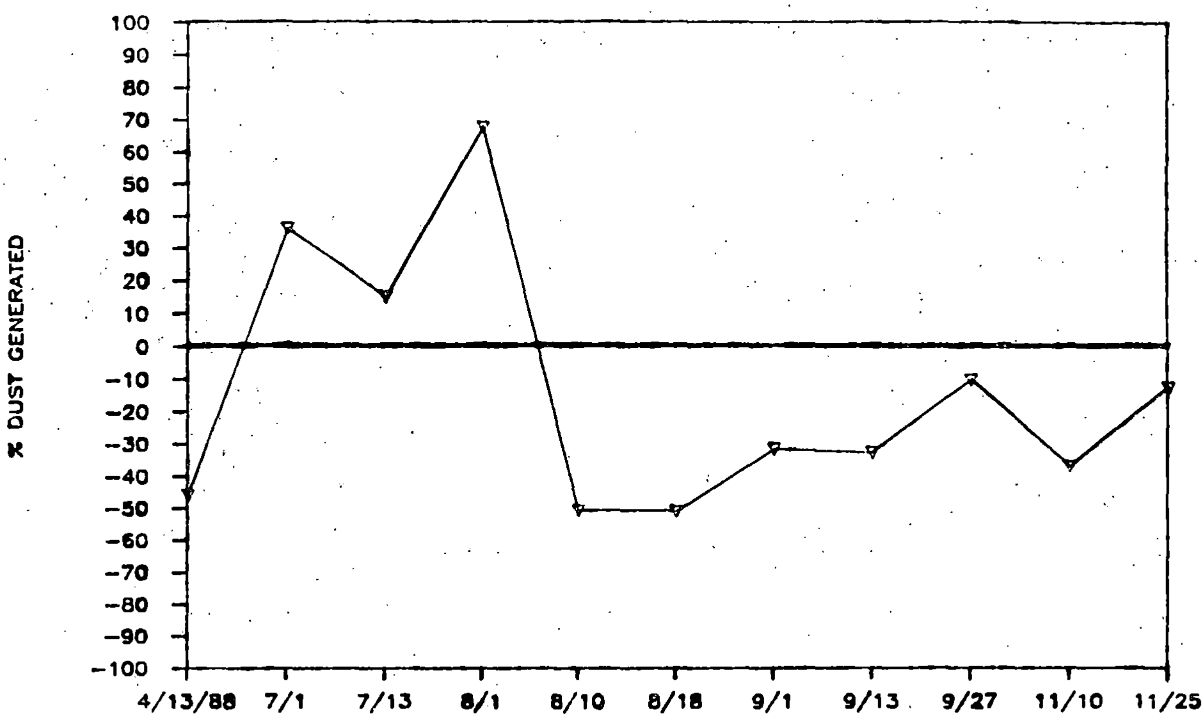


Figure 6. Dust generation, calcium chloride treatment

DUST FROM THE WHEEL PATHS



DUST FROM OUT OF THE WHEEL PATHS

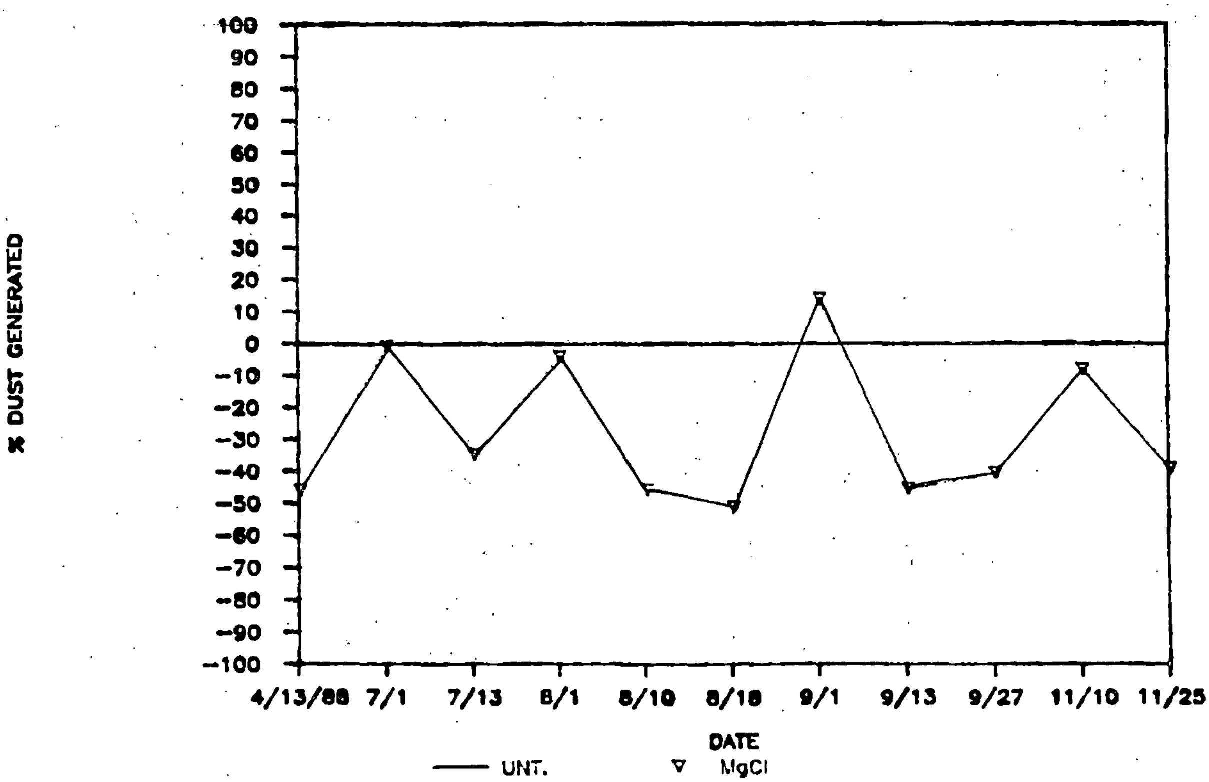


Figure 7. Dust generation, magnesium chloride treatment

percent) reduced, however, in the out of wheelpath tests. The 1.0 and 1.5 percent treatments showed the best reduction. Results obtained after the class A stone surfacing addition in August 1988 are interesting. The 1.5 percent bentonite treatment appears to be effectively reducing dust generation in both wheelpath and out of wheelpath tests. This indicates the fine particulate bonding capability of the bentonite is not only recoverable, but appears to be able to interact and function with newly applied material as well.

Dust generation data for the chloride treated sections are shown on Figures 6 and 7. Data are similar to the bentonite treated data (for in the wheelpath testing) up until the new stone application. The chloride treated sections showed no consistent behavior. Both calcium and magnesium appeared to be reducing dust out of the wheelpath on the order of 10 to 40 percent. After the new stone application in August, the calcium section did not exhibit a consistent trend. The magnesium section results shown on Figure 7, however, indicated that it was acting to reduce dust generation for both test conditions. These results are similar to those for the 1.5 percent bentonite treatment.

Table 1 shows rough averages of wheelpath dust reduction, by treatment type, as presented in the last progress report.

Table 1. Dust reduction averages from 1987 progress report.

Treatment	Percent Dust Reduction Wheelpath
0.5% Bentonite	32
1.0% Bentonite	26
1.5% Bentonite	16
Calcium Chloride	76
Magnesium Chloride	80

For comparison, Table 2 presents average 1988 test results for the period up to the new stone application in August.

Table 2. Dust reduction averages for 1988 through August

Treatment	Percent Dust Reduction Wheelpath	Percent Dust Reduction Out of Wheelpath
0.5% Bentonite	+8	14
1.0% Bentonite	6	25
1.5% Bentonite	7	38
Calcium Chloride	30	27
Magnesium Chloride	3	31

Table 3 shows overall 1988 dust reduction data averages including the period after the new stone application.

Table 3. Dust reduction averages; all 1988 data

Treatment	Percent Dust Reduction Wheelpath	Percent Dust Reduction Out of Wheelpath
0.5% Bentonite	11	12
1.0% Bentonite	11	16
1.5% Bentonite	26	36
Calcium Chloride	15	3
Magnesium Chloride	14	28

Analysis of these data over the entire project to date, indicates the 1.5 percent bentonite treatment to be long-term effective with a potential reduction of dust in the range of 25 to 35 percent. The magnesium chloride treatment also appears effective with a reduction of 15 to 30 percent over the long-term.

Dust generation results obtained since construction for in the wheelpath tests for each test section are given on Figures 1 through 5, Appendix A. During the summer of 1987, it appeared that the 0.5 percent treatment was the most effective of the bentonite treated sections. Current data, however, indicates that the 1.5 percent treatment may be more effective from a long-term standpoint as shown on Figure 3, Appendix A.

Surfacing Material Gradations

Dry and wet sieve analyses were conducted on samples of loose surfacing materials obtained periodically from each of the test sections. Results are shown in Appendix B, and indicate trends similar to those previously reported. The addition of the new surfacing material in August is indicated by a shift of gradation results to the coarse side as indicated by test results after August 15, 1988. Scanning electron microscopic analysis is being conducted on samples obtained before and after new stone application to verify that bentonite bonding of the fine particulates is occurring with the new material.

Braking Characteristics

Braking tests were developed and initiated this year in an attempt to evaluate the braking characteristics of the treated sections. The developed test method used a 1/2 ton Chevrolet pickup traveling at a constant speed of 25 mph. Brakes were locked at that speed, and the braking distance was measured from the start of the skid marks to the front axle. Preliminary results obtained from tests conducted on a dry road surface are shown in Table 4.

Table 4. Preliminary braking test results

Treatment	Braking Distance (ft) Wheelpath	Braking Distance (ft) Out of Wheelpath
0.5% Bentonite	45	50
1.0% Bentonite	36	43
1.5% Bentonite	38	40
Calcium Chloride	35	38
Magnesium Chloride	42	43
Untreated	44	41

Although not statistically significant at this time, preliminary results indicate no adverse affect on braking characteristics for the various treatments after one year of service. The 0.5 percent bentonite section appeared to have a longer braking requirement. Future testing will be conducted on wet and dry surfaces for comparison, and will be initiated immediately after new test road construction.

CONCLUSIONS

Testing conducted to date on the Dallas County test road indicates the following.

- For the bentonite applications, the 1.5 percent treatment appears to be outperforming the other sections and exhibiting a 25 to 35 percent overall average reduction after a year of service.

- The bentonite treatment appears capable of reducing the dust generation after new maintenance surfacing application. Again, the 1.5 percent treatment appears the most effective.

- The fine particulate (-#200) bonding and aggregation mechanism of the bentonite treatment appears recoverable from environmental affects of winter, and from alternating wet and dry periods.

- The magnesium chloride treatment appears capable of long-term reduction (over one year) and exhibited a 15 to 30 percent overall average reduction. It also appears to assist in dust reduction after new material application.

- Preliminary braking tests indicate no adverse characteristics with respect to treatments that are over one year of age.

RECOMMENDATIONS

For the next two test roads, the following research plan modifications are recommended.

- Install test sections incorporating up to 3.0 percent bentonite treatments.
- Eliminate stationary ditch collection of dust.
- Initiate braking tests immediately after construction, and conduct the tests under both wet and dry road surface conditions.

APPENDIX A

WHEELPATH DUST GENERATION DATA

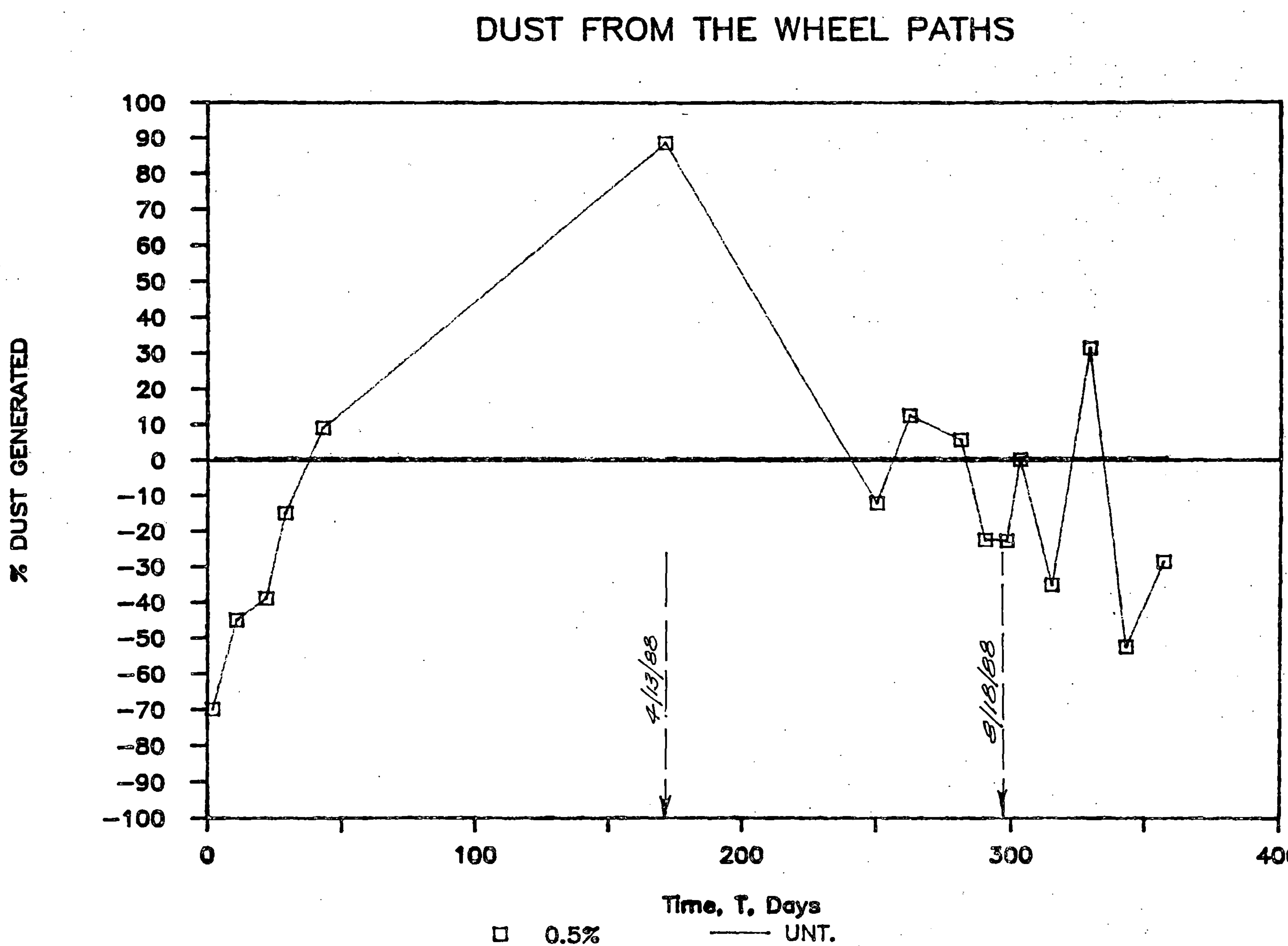


Figure 1. Wheelpath dust results since construction, 0.5% bentonite

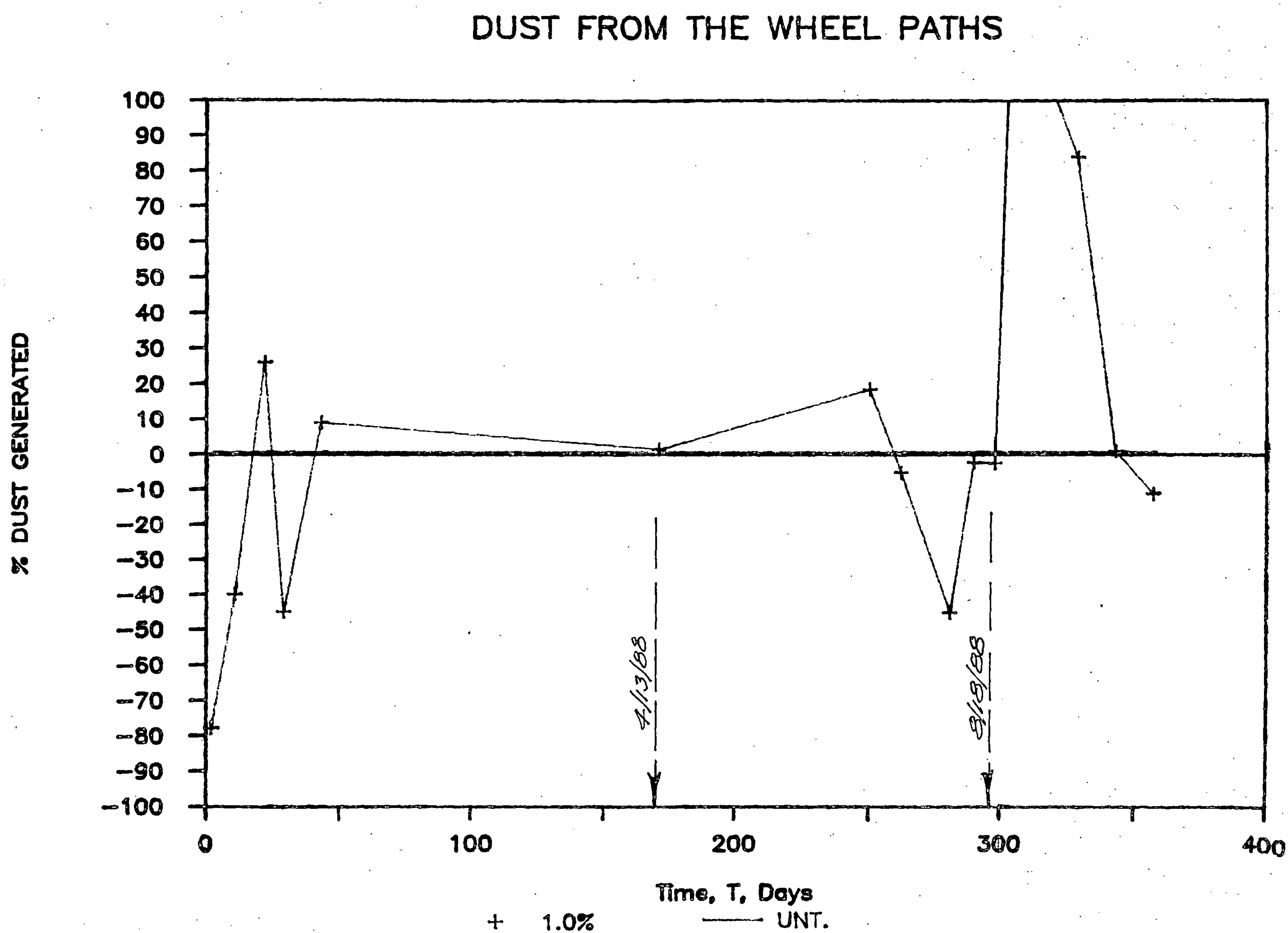


Figure 2. Wheelpath dust results since construction, 1.0% bentonite

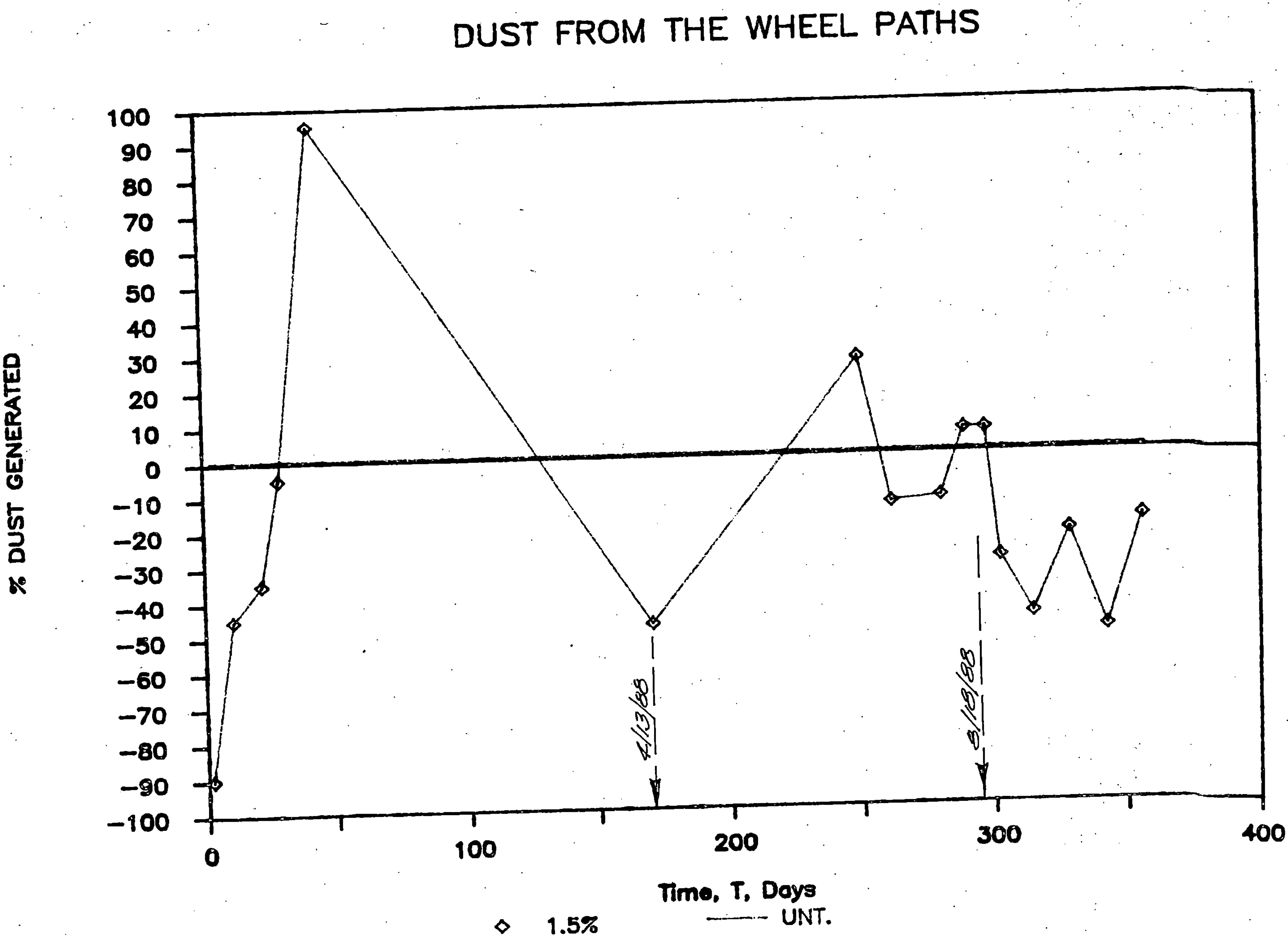


Figure 3. Wheelpath dust results since construction, 1.5% bentonite

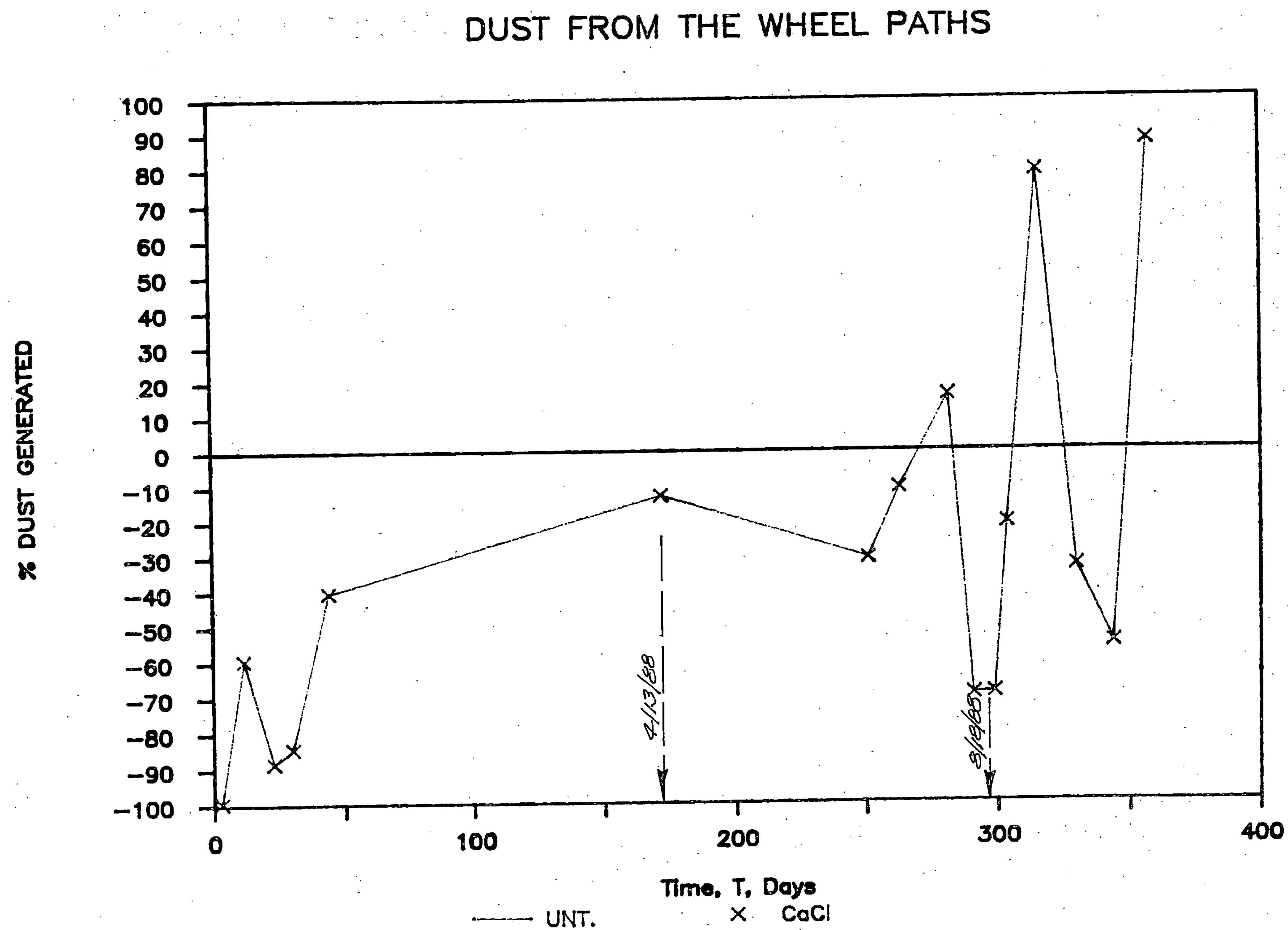


Figure 4. Wheelpath dust results since construction, Calcium chloride

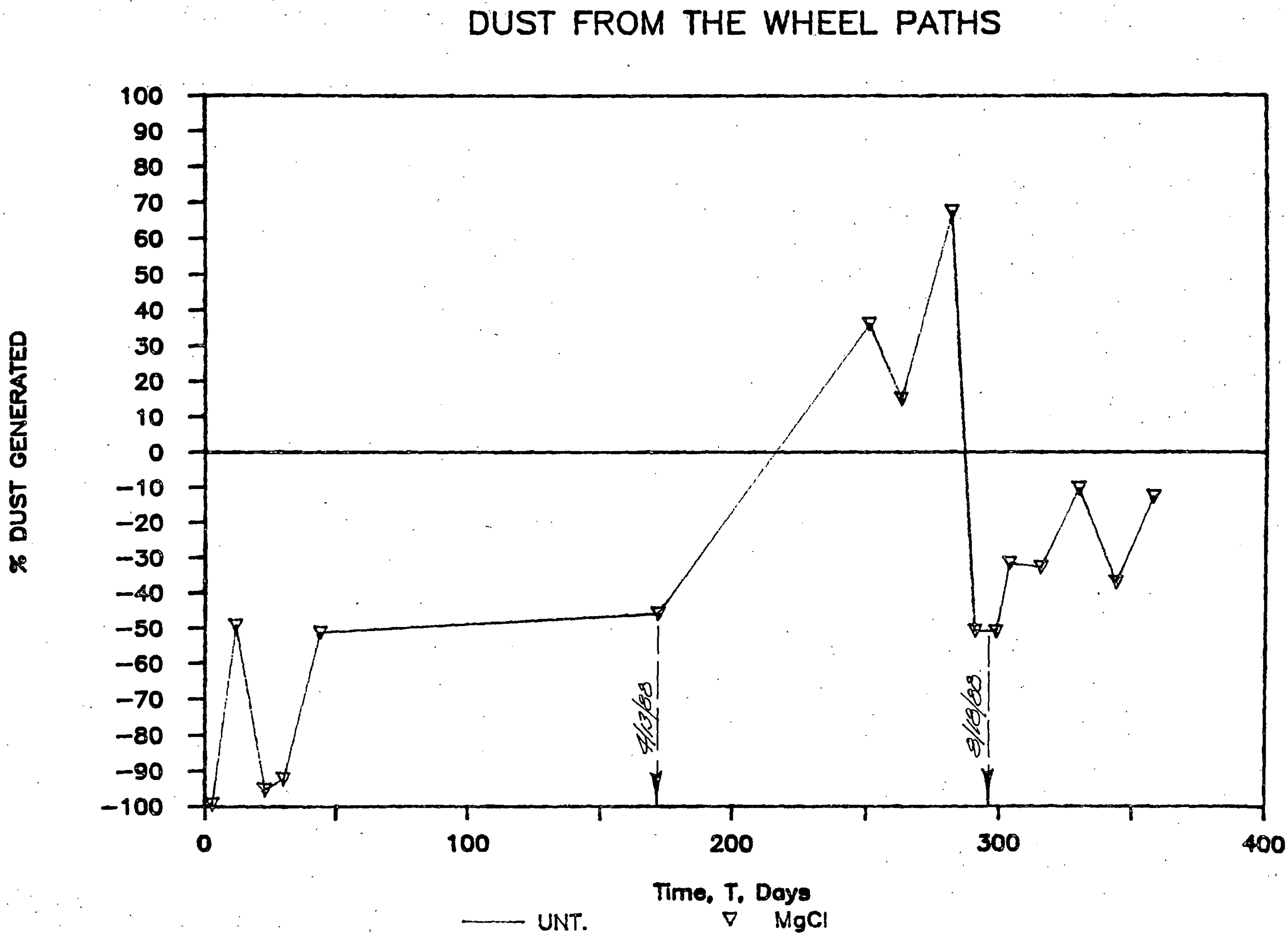


Figure 5. Wheelpath dust results since construction, Magnesium chloride

APPENDIX B

SURFACING MATERIAL GRADATION DATA

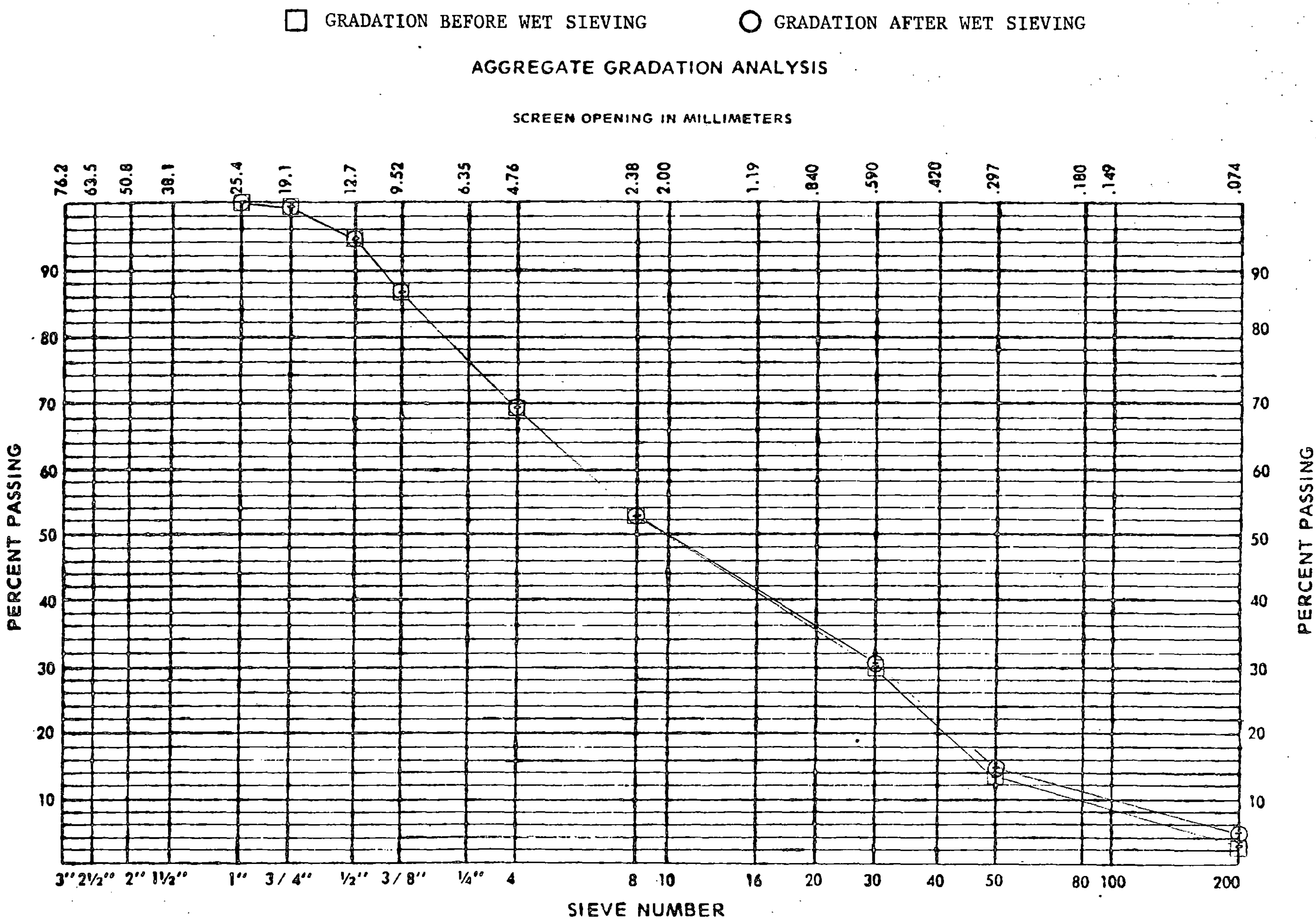


Figure 1. Section 1, 1.0% bentonite (08/10/88)

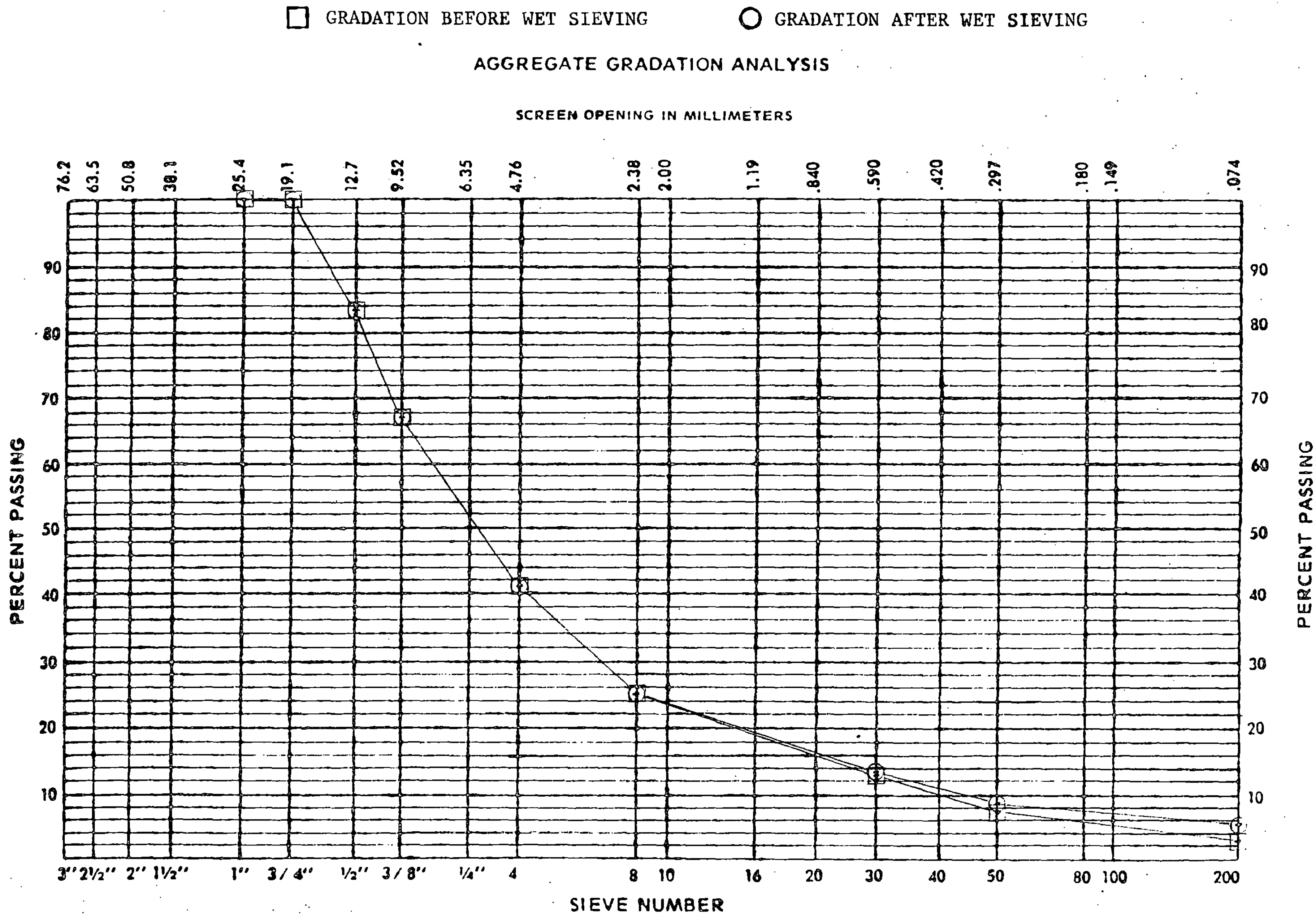


Figure 2. Section 1, 1.0% bentonite (09/13/88)

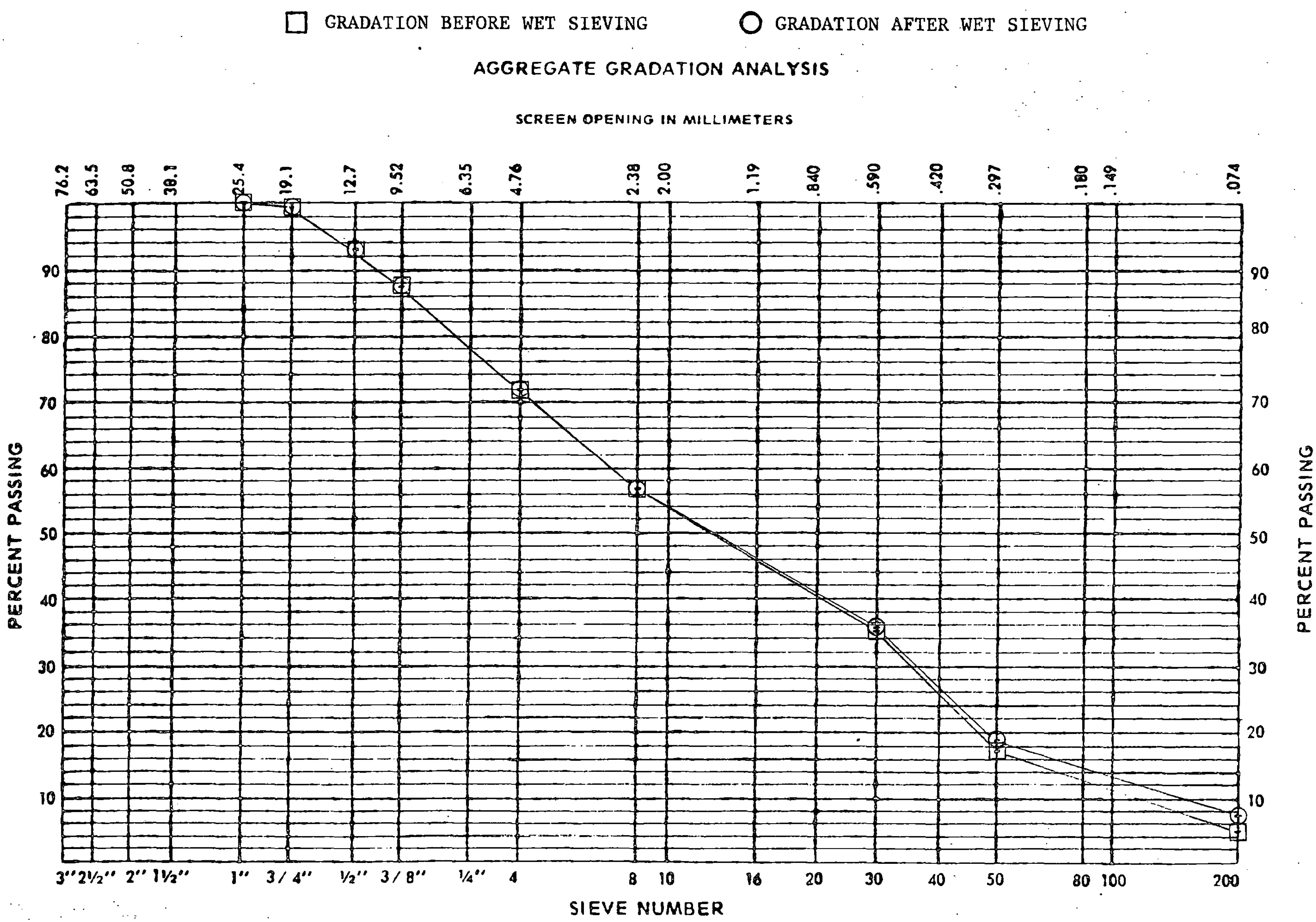


Figure 3. Section 2, Untreated (08/10/88)

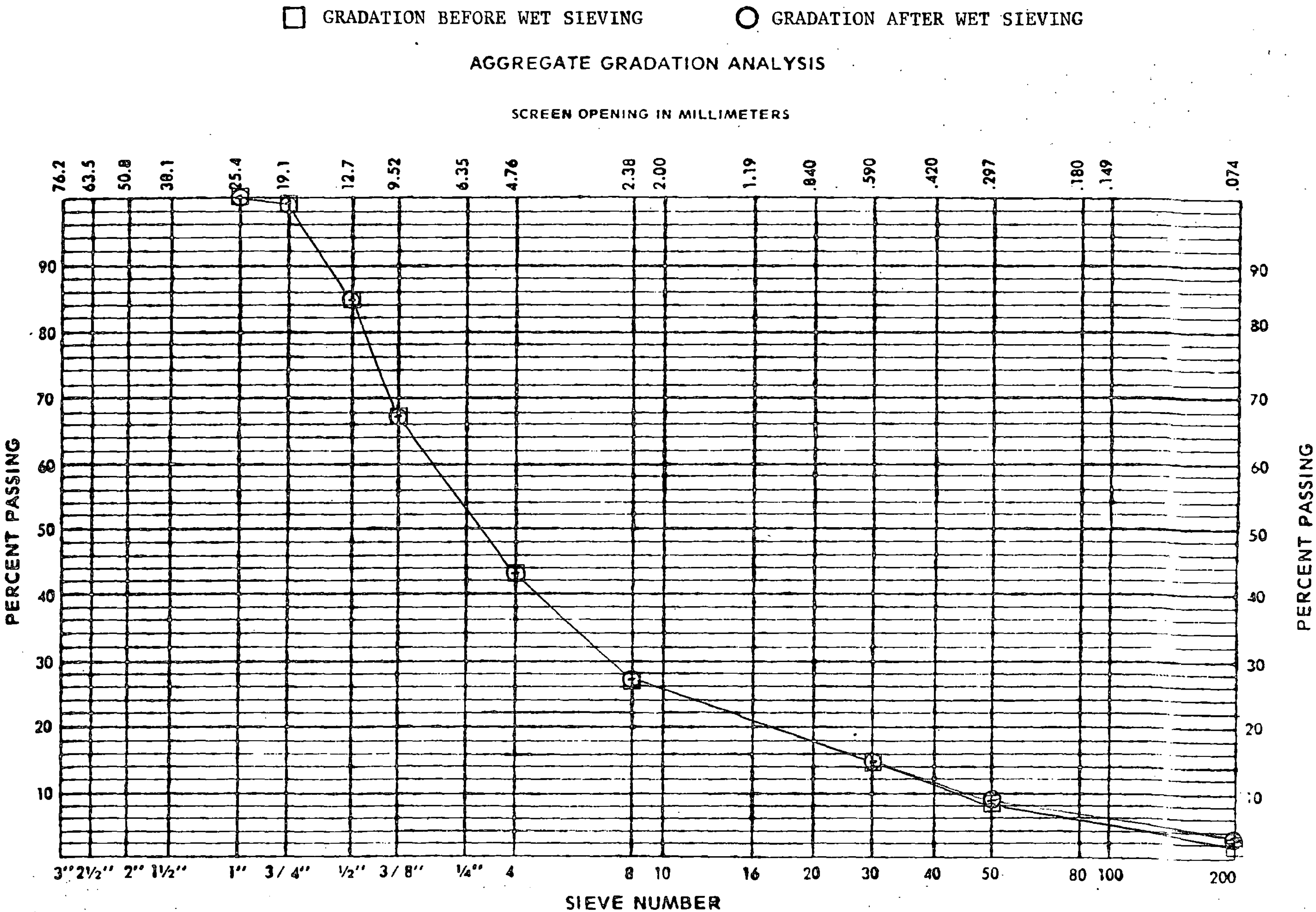


Figure 4. Section 2, Untreated (10/25/88)

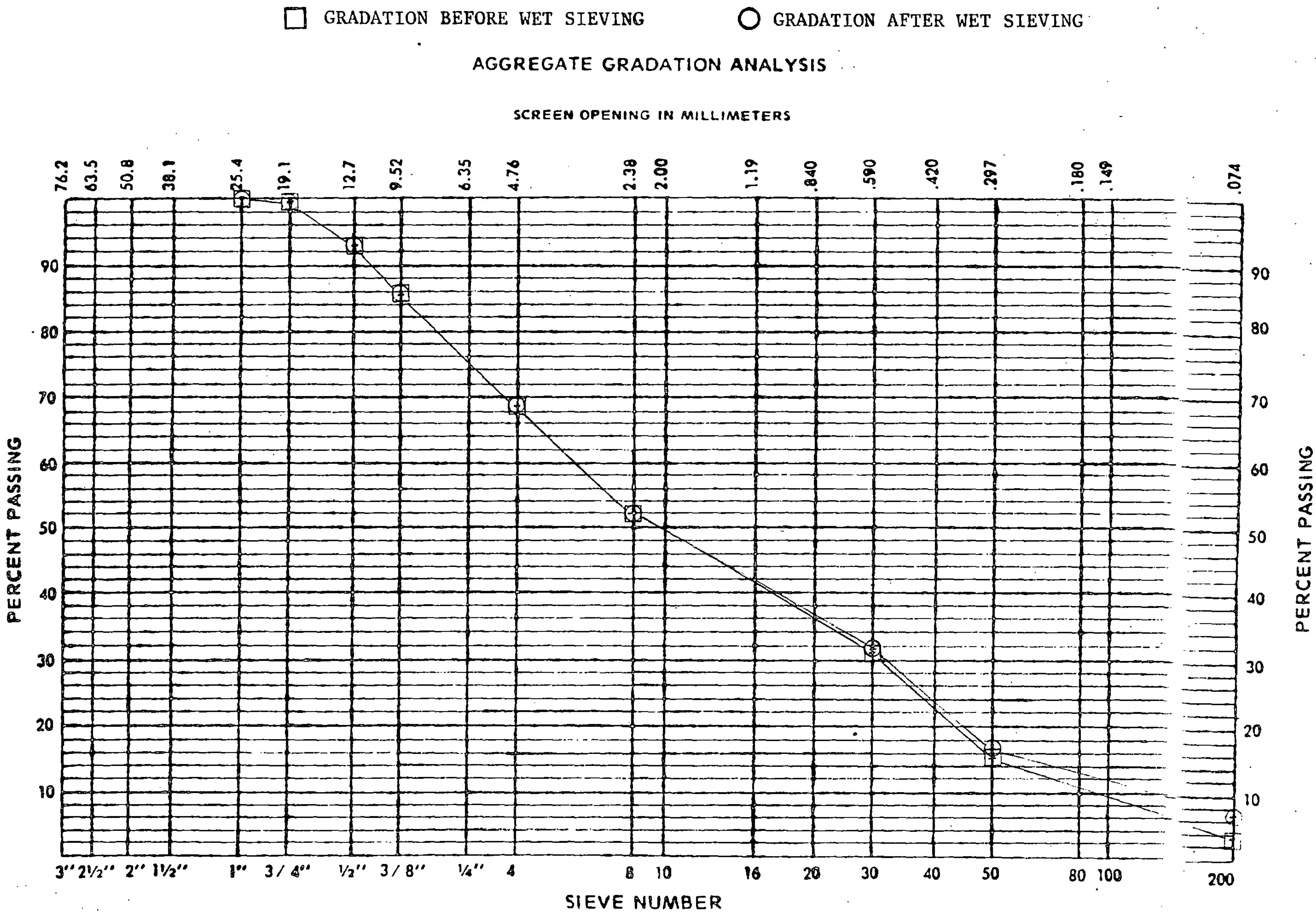


Figure 5. Section 3, 0.5% bentonite (08/10/88)

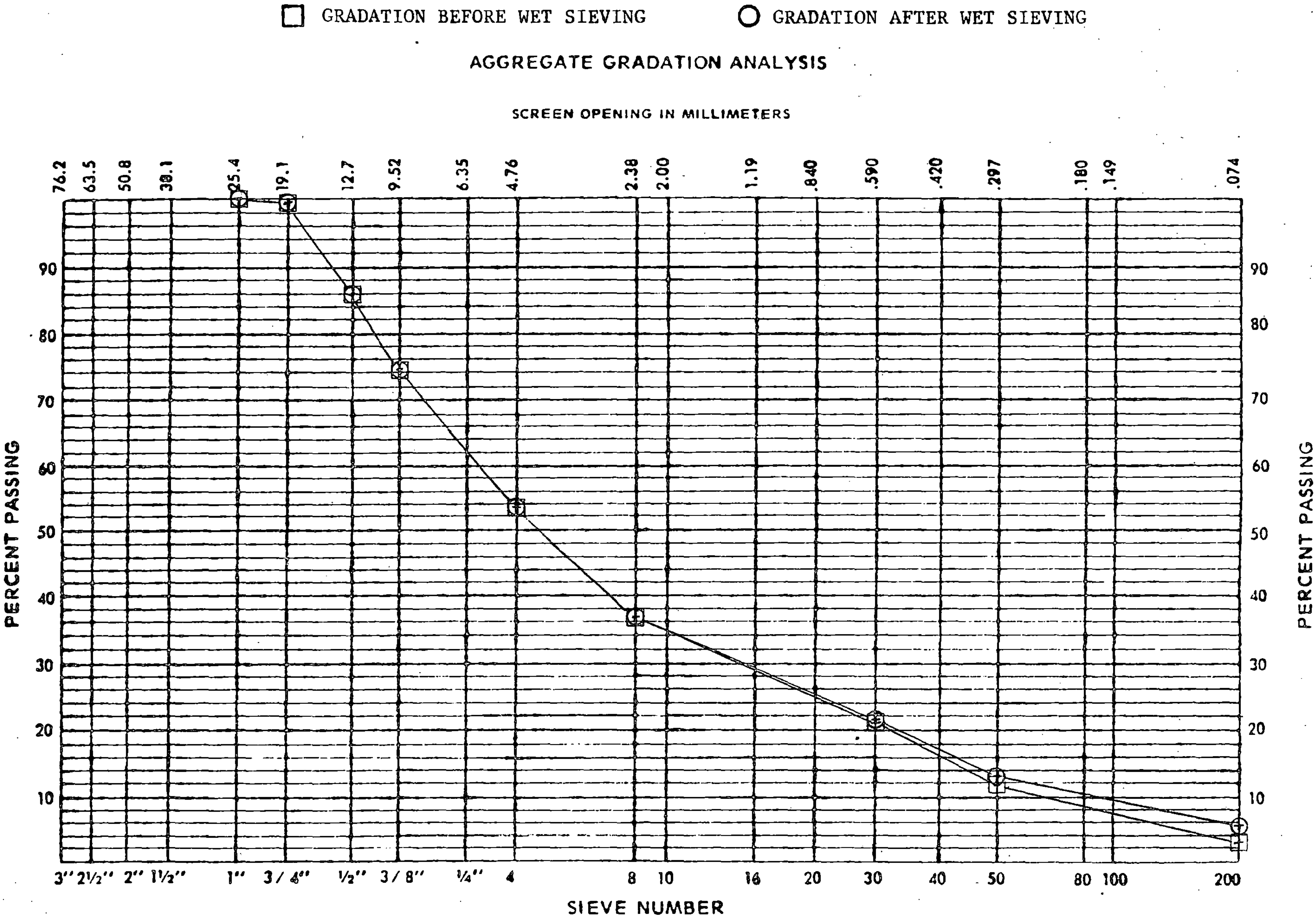


Figure 6. Section 3, 0.5% bentonite (10/25/88)

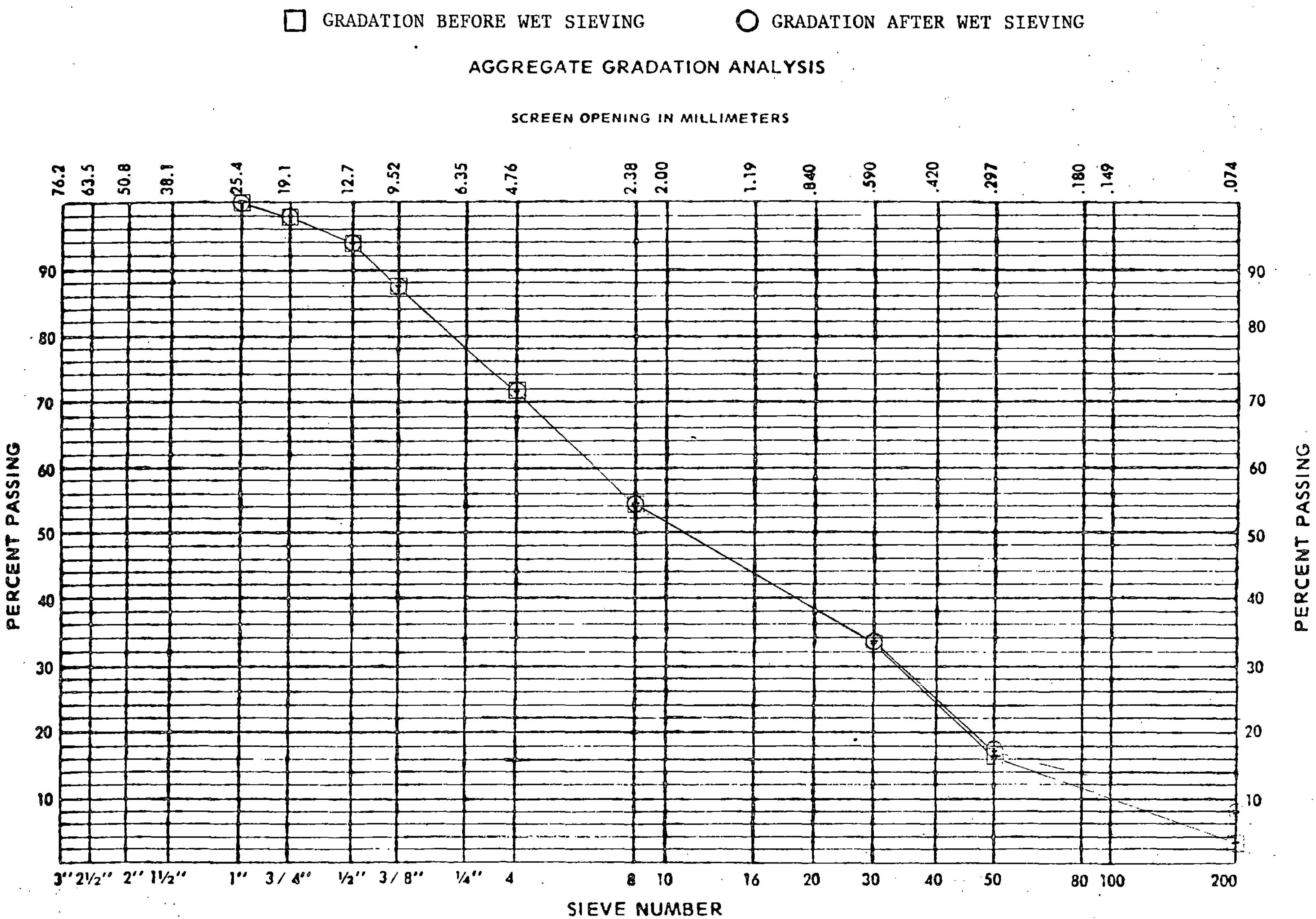


Figure 7. Section 4, Calcium chloride (08/10/88)

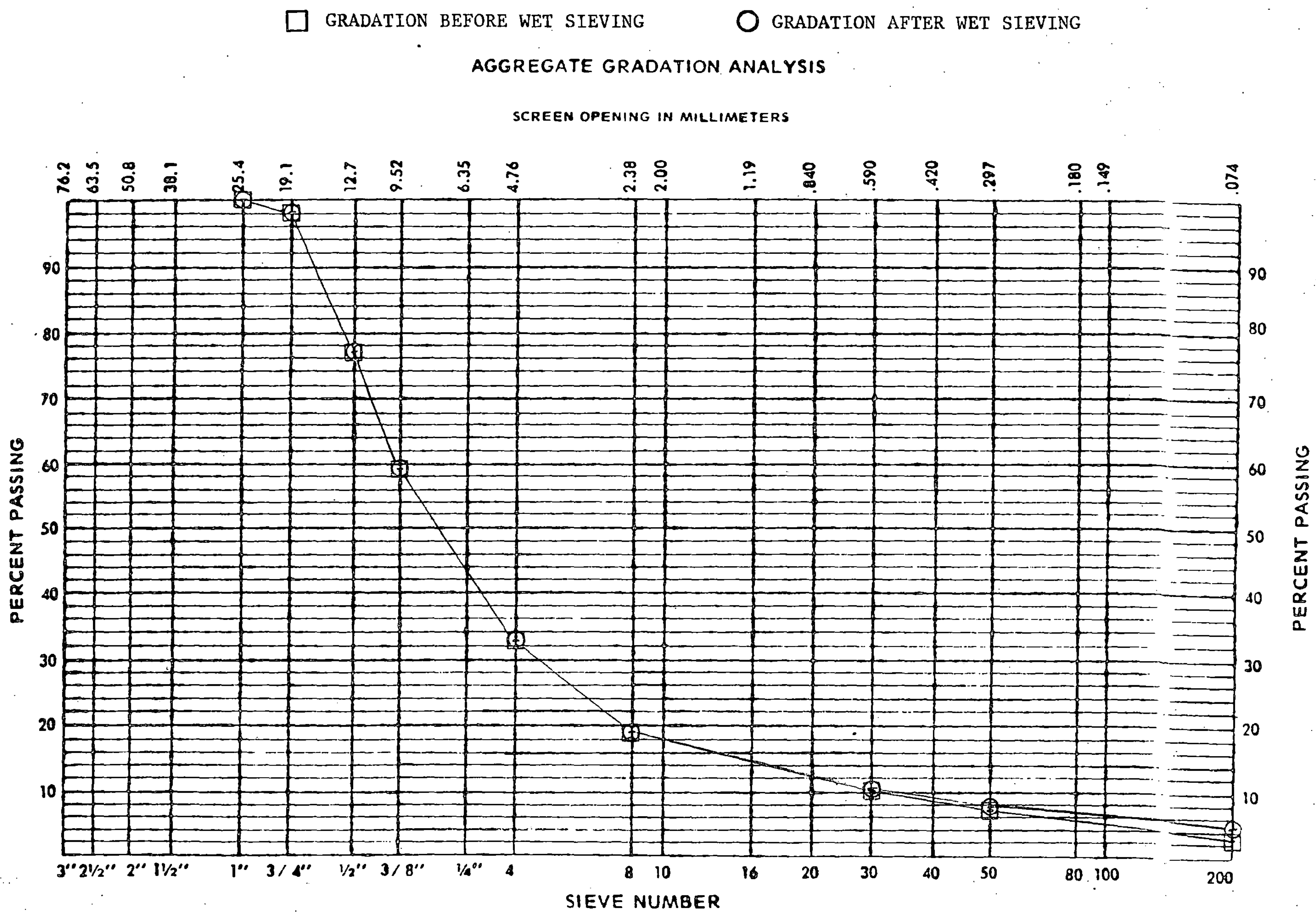


Figure 8. Section 4, Calcium chloride (10/25/88)

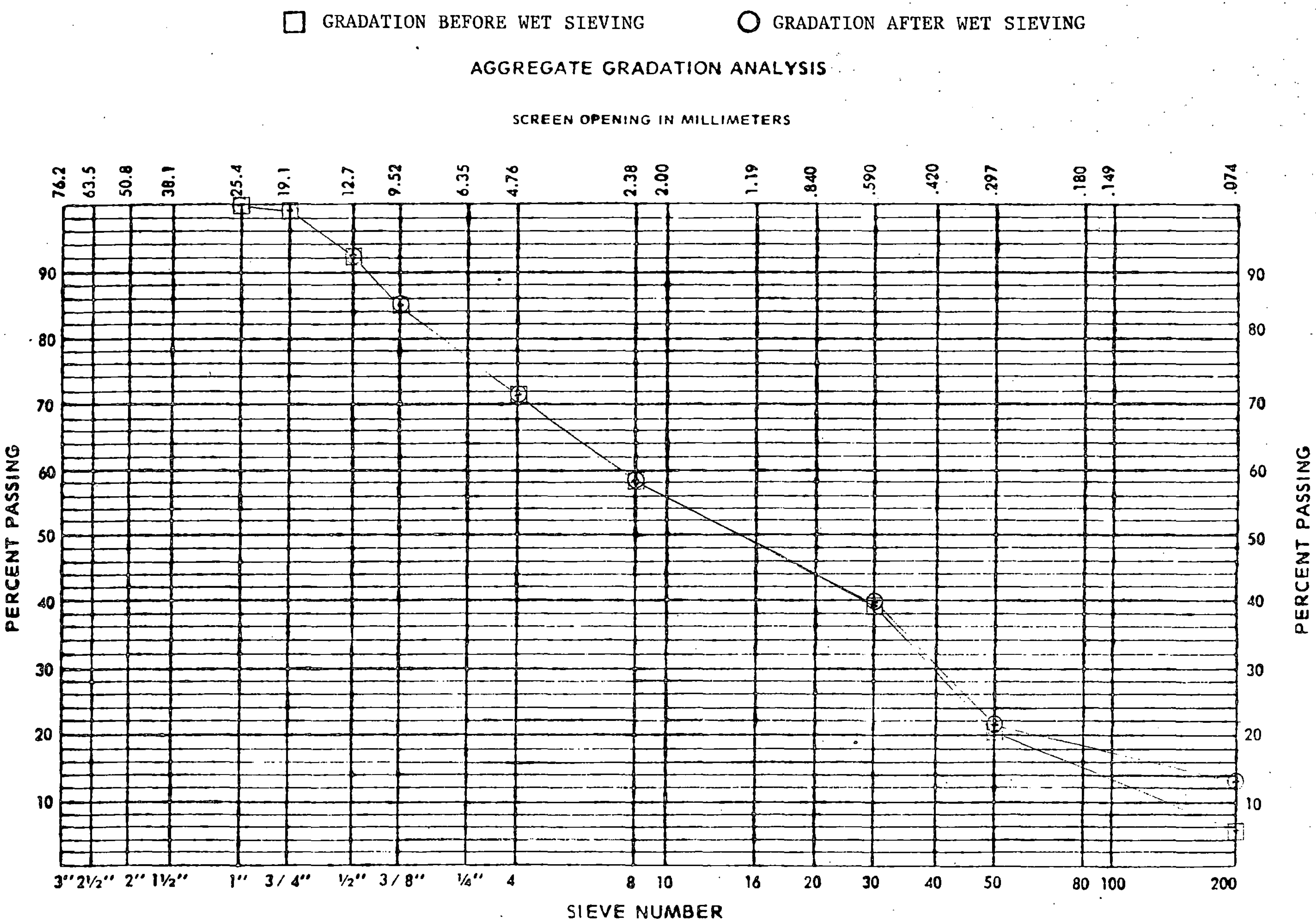


Figure 9. Section 5, 1.5% bentonite (08/10/88)

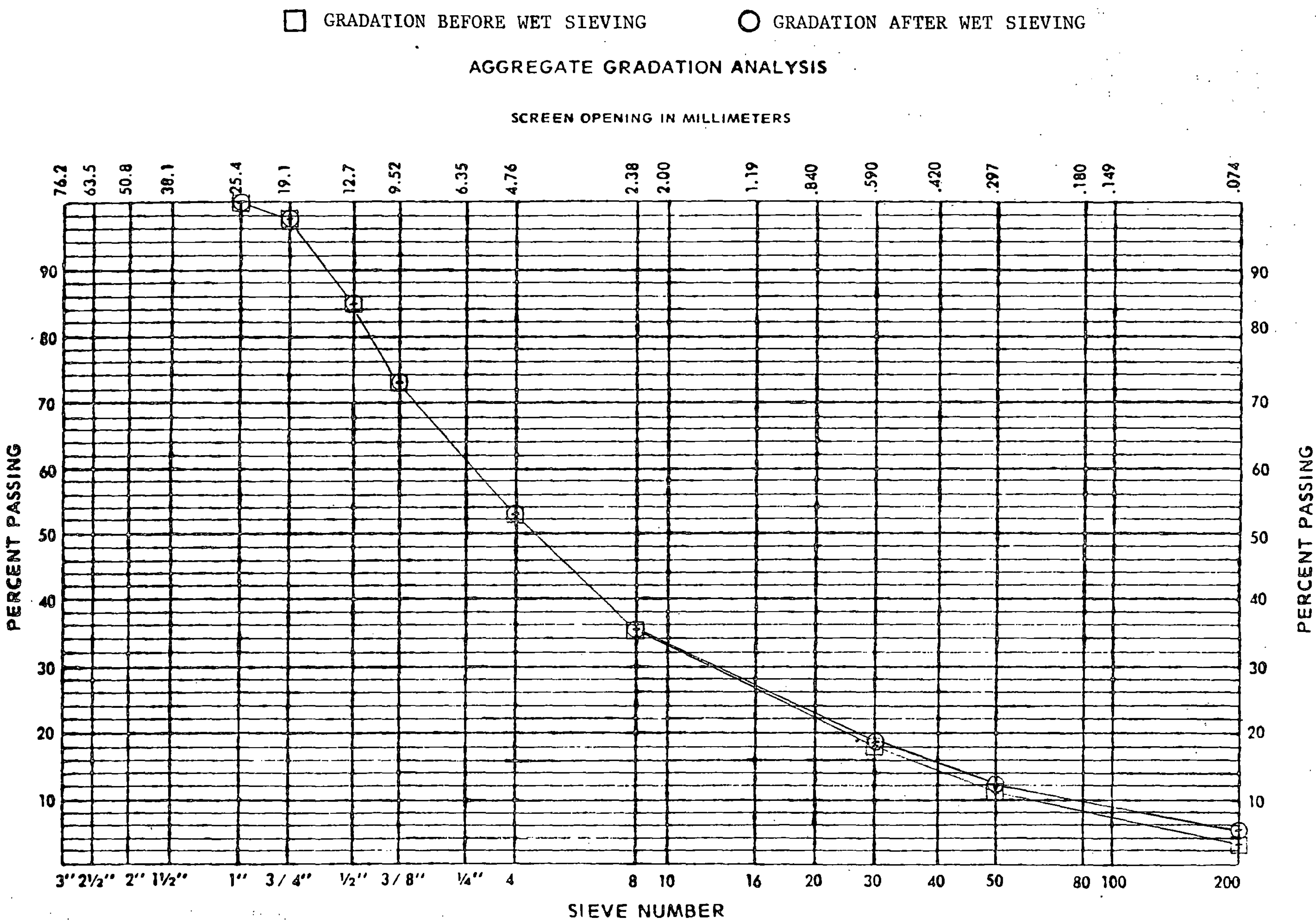


Figure 10. Section 5, 1.5% bentonite (10/25/88)

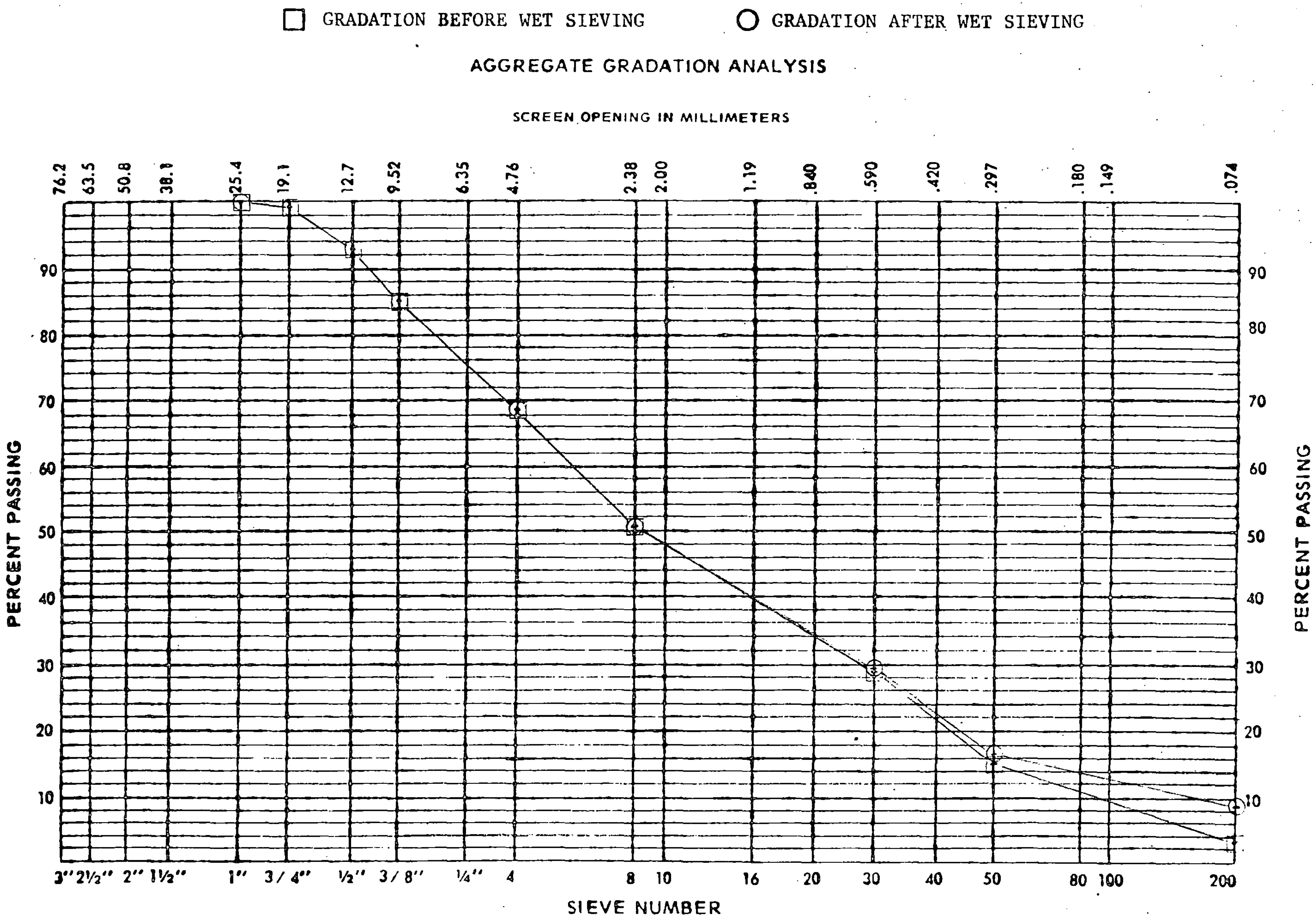


Figure 11. Section 6, Magnesium chloride (08/10/88)

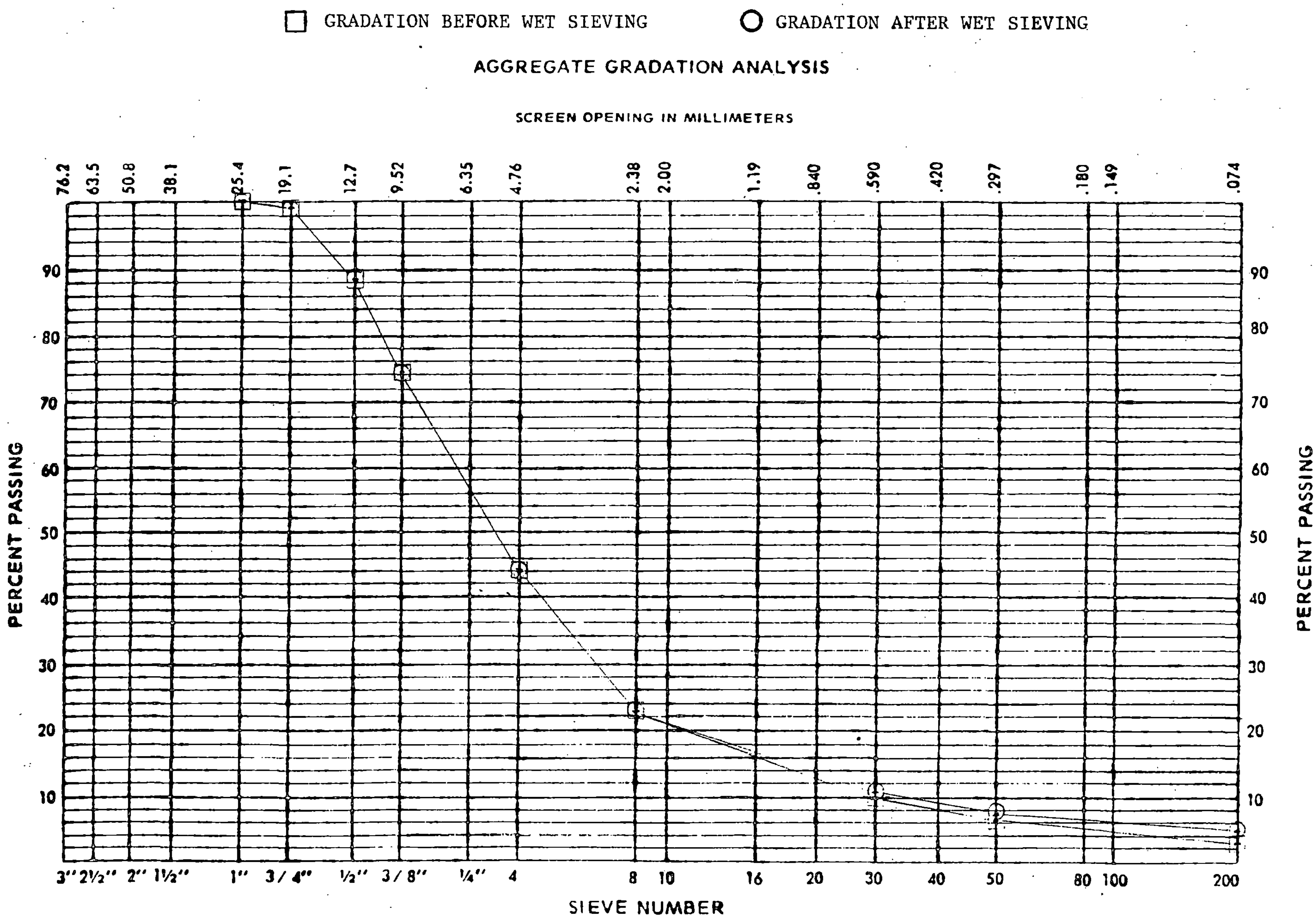


Figure 12. Section 6, Magnesium chloride (09/13/88)